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Appendix B: Base Case Forecast of California Transportation Energy Demand (Task 2)

FINAL STAFF REPORT

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Base Case Forecast of California Transportation Energy Demand

Introduction

This staff report was prepared as part of the AB 2076 (Chapter 936, Statutes of 2000) analysis. Assembly Bill 2076 (Chapter 936, Statutes of 2000) requires the California Energy Commission and the California Air Resources Board to develop and submit a strategy to the Legislature to reduce petroleum dependence in California. The statute requires the strategy to include goals for reducing the rate of growth in the demand for petroleum fuels. Options to be considered include increasing transportation energy efficiency and using non-petroleum fuels and advanced transportation technologies including alternative fueled vehicles and hybrid vehicles.

The Energy Commission and the Air Resources Board have developed a program and methodologies to evaluate and analyze these possible options. The goal of this effort is to provide policy makers with a robust analysis of the possible measures that could be implemented to meet the fuel demands of consumers and industry. This analysis needs to account for the costs of these measures as well as the benefits. The overall effort is guided by consultant services provided by Acurex Environmental, an Arthur D. Little Company.

This work has been divided into several tasks and assigned to the appropriate agency staff.

Task 1: The objective of the first task, led by the ARB, was to determine the possible environmental net benefits of reducing the demand for gasoline and diesel fuel in California. For each petroleum reduction option, the ARB quantified the benefits of reducing petroleum consumption including air quality, global warming, and other impacts. The benefits were then translated into monetary terms and presented in the technical appendix entitled ***Appendix A: Benefits for Reducing Demand for Gasoline and Diesel (Task 1)***.

Task 2: The second task was led by the Energy Commission to determine the future demand for refined products, particularly gasoline and diesel fuels. The results of this task are contained in this technical appendix, entitled ***Appendix B: Base Case Forecast of California Transportation Energy Demand (Task 2)***.

Task 3: The objective of this task, led by the Energy Commission, was to assess possible options to reduce petroleum dependency and to determine the level of petroleum reduction and costs. The amount of gasoline and diesel fuel reduced, the consumer cost, and the change in government revenue were determined for each of the options. The results of this effort are summarized in the technical appendix entitled ***Appendix C: Petroleum Reduction Options (Task 3)***.

Task 4: The Energy Commission and the Air Resources Board jointly led Task 4, which provided an integration of the results of Tasks 1, 2, and 3. The results of this task are contained in a technical appendix entitled ***Appendix D: Costs and Benefits of Reduction Options (Task 4)***.

Report Structure

This staff report responds to the legislative requirement that the Energy Commission include a base case forecast of gasoline, diesel and petroleum consumption in 2010 and 2020. Specifically, the report describes the following:

- California's Historical Demand for Transportation Energy. California is home to about 35 million people. Until recently, the state had a remarkable period of rapid economic growth. Economic conditions and population growth helped to drive a robust demand for transportation fuels and an associated demand for transportation services.

- Key Factors Affecting Future Transportation Energy Demand. Growing demand for transportation fuels is influenced by population growth, growth in the state's economy, and growth in Vehicle Miles Traveled (VMT). Also contributing to the demand for transportation energy are consumers' vehicle preferences, fuel prices, and regulatory policies.[1] Changing land-use patterns and increasing traffic congestion affect transportation energy demand, as well.

- Base Case Forecast Methodology. This forecast is based on our best estimates of economic and population growth, petroleum base fuel supply and availability, vehicle efficiency and utilization of alternative fuels and advanced transportation technologies.

- Base Case Forecast Results. VMT is growing faster than population, at an average rate of 1.8 percent annually when compared to population growth of 1.4 percent. On-road gasoline demand will increase an average of 1.6 percent annually over the next 20 years. On-road diesel demand will increase by an average of 2.4 percent annually over the same time period.

- Alternative Forecast. The Energy Commission also examined the effects of a more optimistic fuel economy growth rate.

California's Historical Demand for Transportation Energy

From 1980 through 2000, California's population grew by an average of 1.9 percent per year, and the number of on-road vehicles grew at nearly the same rate. In part because of rising, real per-capita income, total on-road travel in the state increased at a significantly higher rate than either population or vehicles—an average of 3.3 percent annually while, at the same time, gasoline and diesel demand increased by an average of just 1.8 percent.

The fact that travel since 1980 has increased at almost twice the rate of population growth is also explained by two phenomena: declining real gasoline prices through the mid-1980s and rising vehicle fuel economy through the late 1990s. Since 1980, the real cost of gasoline has dropped by 40 percent while fleet-average fuel economy has nearly doubled.[2] As a result, the average per-mile cost of gasoline is less than one-half of what it was in 1980. Figure 1.1 shows the average per-mile cost (in $2000) of operating a gasoline-powered light-duty vehicle (LDV) over the period from 1980 to 2000.

Figure 1.1: Average Per-Mile Cost of Gasoline, 1980-2000

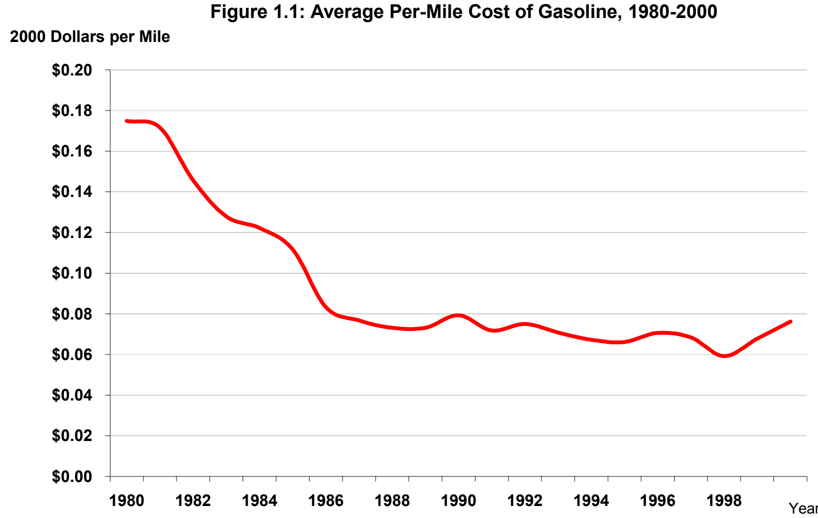


Figure 1.2 shows the slate of petroleum fuels Californians consumed from 1985 through 1999.[3] The decline in petroleum demand during the late 1980s and early 1990s and the resumption of demand growth in the middle 1990s are indicative of the way economic activity affects transportation demand; these patterns closely follow California's economic conditions in the post Cold War era.

Figure 1.2: Demand for Petroleum-Based Transportation Fuel in California, 1985-1999

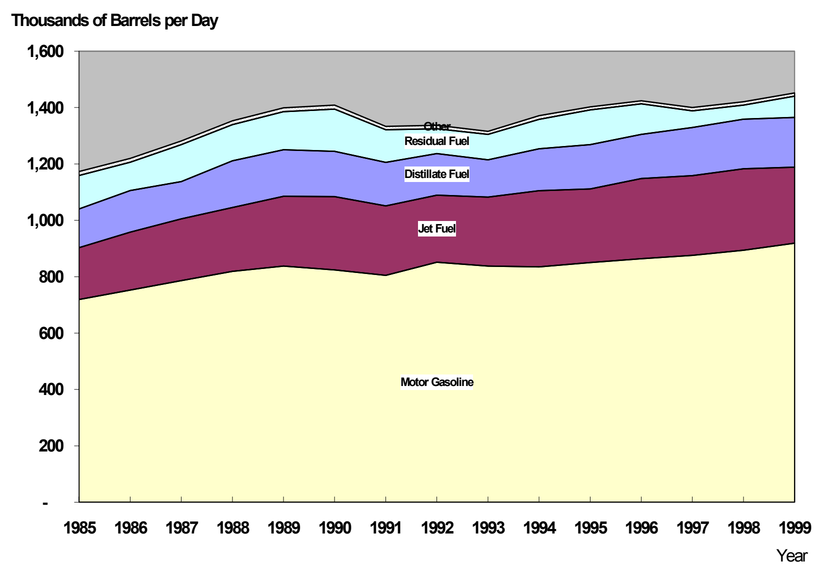


Table 1.1 shows that the demand for motor gasoline in 1999 exceeded that of jet fuel, the second largest use, by a factor of three. Distillate, primarily diesel, is used for both on-road and off-road vehicles. On-road vehicles use about 87 percent of the distillate consumed in California, and railroad applications use another 9 percent.[4]

Table 1.1: California Petroleum Demand in the Transportation Sector—1999

Fuel Type	Percent	Thousands of Barrels per Day
Motor Gasoline	63.3%	919
Jet Fuel	18.6%	270
Distillate	12.1%	176
Residual	5.2%	76
Other	0.8%	12
Total	100.0%	1,453

Light-duty vehicles include automobiles, and pickup trucks, vans, and sport utility vehicles (SUVs) that are collectively termed "light trucks." Light-duty vehicles conduct nearly all of California's on-road passenger movement. In 2000, Californians registered about 22 million gasoline-powered vehicles. Small fleets of liquefied petroleum gas, natural gas, alcohol, and electric vehicles, cumulatively totaling about 120,000 (or approximately six-tenths of 1 percent of the vehicle population), also operate in California. In 2000, Californians purchased 1,126,000 new cars and 965,000 new light trucks. Commercial fleet vehicles account for about one third of these purchases.

The average fuel economy of gasoline-powered light-duty vehicles has steadily increased since the mid-seventies from about 12.6 miles per gallon to today's 20.7 miles per gallon. However, consumers' growing preference for light trucks, particularly minivans and sport utility vehicles, which have lower average fuel economy, has caused fleet-average fuel economy to level off for the first time since 1973.

Heavy-duty vehicles include medium and heavy trucks and buses. Most heavy-duty vehicles provide on-road freight movement; a much smaller number transport passengers. About 750,000 heavy-duty vehicles are registered in California, which use approximately 2.6 billion gallons of diesel and 0.9 billion gallons of gasoline annually (heavy-duty vehicles are generally defined as those vehicles that weigh over 10,000 pounds).

Key Factors Affecting Future Transportation Energy Demand

As stated above, economic conditions and population growth are the primary drivers of transportation energy demand. The projected increases in VMT and consumer preferences for larger, less fuel-efficient vehicles have also influenced the growing demand for gasoline and diesel fuels.

Using the California Department of Finance projections, the Energy Commission assumes that California's population will grow by an average of 1.4 percent per year over the next 20 years. This projection translates to approximately 10 million more Californians by 2020—slightly below the average annual rate of the last 20 years, reflecting an aging of the large "baby boom" generation. The Energy Commission assumes that unemployment in the State will remain relatively low (i.e. around 5 percent) over the next 20 years and real per-household income will grow at an average annual rate of about 1.5 percent.[5] This is somewhat less than the rate of 1.9 percent of the past 20 years. The forecasts were made before September 11, 2001, and no attempt has been made to identify long-term impacts related to these events.

Base Case Forecast Methodology

To develop a transportation energy demand forecast (including jet fuel, gasoline, diesel, electricity, and natural gas), the Energy Commission has forecasted number of aircraft passengers, vehicle miles traveled (VMT) and the number and characteristics of cars, trucks, buses, and light-rail transit vehicles. The gasoline demand forecast covers freight, transit, and light-duty vehicle consumption. The forecast for diesel fuel includes on-road freight and transit use. The forecast includes a base case and one alternative case.

The base case assumes that the fuel economy of new conventional light-duty vehicles will remain constant for all vehicle classes, generally consistent with trends for cars and light trucks since 1986.[6]

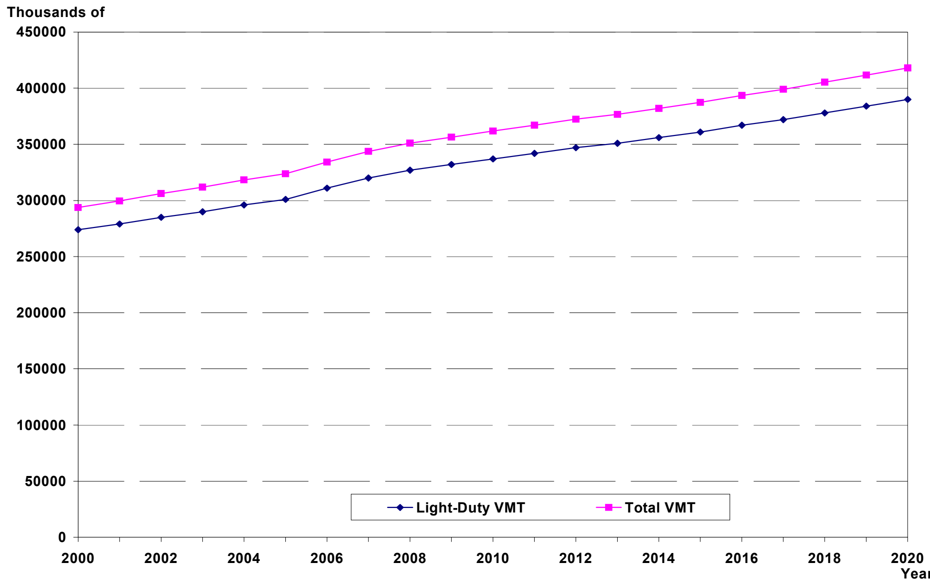
The base case forecast assumes full hybrid-electric vehicle penetration levels consistent with the California Air Resources Board Alternative Techology Partial Zero Emission Vehicle (AT-PZEV) requirements (along with a sufficient number of dedicated electric vehicles to meet ZEV requirements). Full hybrids, e.g. Toyota Prius, are projected to provide fuel economy improvements of about 50 percent, with incremental costs of about $4000-$5000 over similar conventional gasoline vehicles. By 2020, 26 makes and models of full hybrids are assumed to be available. The price of full hybrids (as projected by K.G. Duleep) had to be reduced in the CALCARS vehicle model to meet these AT-PZEV requirements, sometimes by as much as 40 percent.[7]

For the forecast period, the Energy Commission's base case forecast assumes long-term gasoline prices $1.64 per gallon in 2001 dollars for the forecast period based on world crude oil prices of $22.50 per barrel and California's continuing need to import refined gasoline products.[8] Finally, the Energy Commission assumes that smaller sport and cross utility vehicles will continue to increase as a percentage of new light-duty vehicle sales through 2010, at a declining rate matching the trend of the last few years (at roughly 1 percent per year now and declining steadily so that there is no increase in market share after 2010).[9] This rate means that sports utility vehicles would reach 22 percent of new light-duty vehicle sales by 2010 and remain relatively constant thereafter.[10]

Base Case Forecast Results

The Energy Commission projects that on-road VMT (light-duty vehicles, freight, and transit) will increase in California from 295 billion miles in 2000 to 360 billion miles in 2010 to almost 420 billion by 2020. This projection represents an average increase of 1.8 percent per year over the forecast period. Light-duty vehicle VMT, which makes up about 95 percent of the total, is expected to increase from 274 billion miles to just under 390 billion miles over the forecast period, also a rate of 1.8 percent per year. Figure 1.3 shows the projected trend in VMT for light-duty vehicles and all uses combined.

Figure 1.3: Base Case Vehicle Miles Traveled



By 2020, the Energy Commission projects that the number of on-road vehicles will reach over 31.5 million in California, up from about 22.8 million in 2000 (of which over 97 percent are light-duty vehicles), an average growth rate of 1.65 percent per year. Primarily because of the continued growth in the smaller sport and cross utility vehicles, the forecast projects that light trucks will continue to increase as a fraction of light-duty vehicle stock in California, making up over 44 percent by 2020, up from 39 percent in 2000. This assumption, combined with that of no fuel economy growth for new conventional gasoline vehicles, yields a forecast that shows light-duty vehicle fleet-average fuel economy decreasing slightly over the forecast period, from 20.77 mpg in 2000 to 20.75 mpg in 2020, in spite of the large number of full hybrids projected to be on the road.

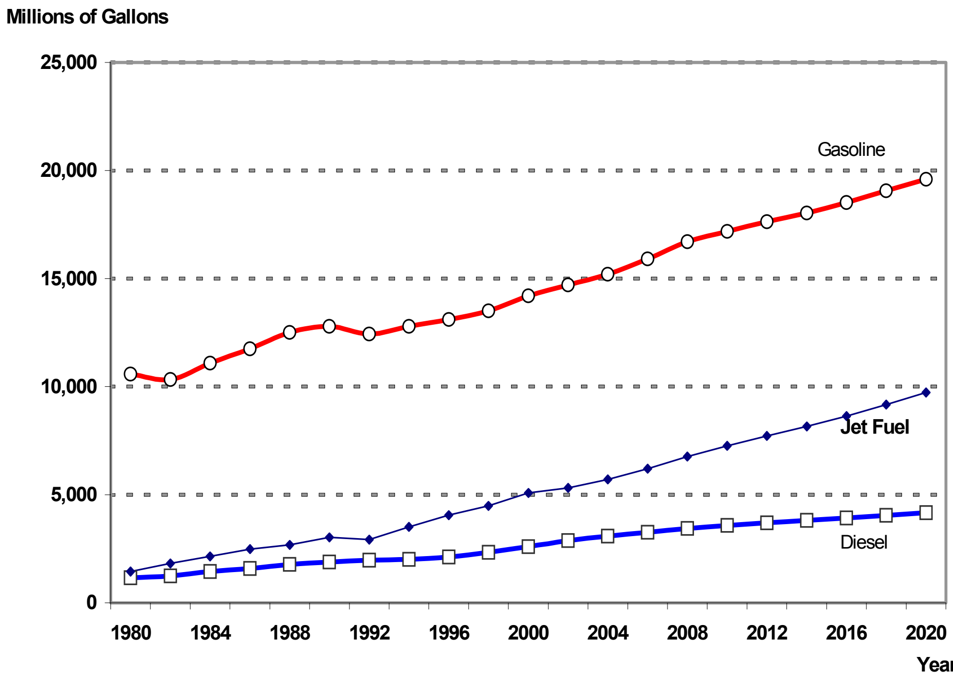
The forecast of jet fuel demand is based on projecting growth of commercial aviation passenger volume in California from 177 million in 2000 to 328 million in 2020. The forecast assumes the fuel use per seat mile will decline 0.7 per cent annually.

Base case projections for electricity and compressed natural gas (CNG) demand include transit as well as light-duty applications. The Energy Commission derived the transit portion of its CNG demand forecast using information from various transit districts.

The Energy Commission's base case forecast projects on-road gasoline demand to increase from 14.2 billion gallons in 2000 to 17.2 billion gallons in 2010 and to 19.6 billion gallons by 2020. Jet fuel demand is projected to increase from 5.1 billion gallons in 2000 to 7.3 billion gallons in 2010 and to 9.2 billion gallons by 2020. Diesel demand is projected to increase from 2.6 billion gallons in 2000 to 3.6 billion gallons in 2010 and to 4.2 billion gallons by 2020. These forecasts translate to an average increase of about 1.6 percent per year for gasoline, 3.4 percent annually for jet fuel, and about 2.4 percent for diesel. Figure 1.4 shows historical and projected demand for on-road gasoline, jet fuel and diesel. In the base case, projected full-hybrid vehicles sales increase from 4,400 in 2001, to 68,000 in 2010, to 158,000 by 2020 (about 6 percent of total sales).

Demand for electricity in the transportation sector is expected to grow from 540 to 3,000 million kilowatt-hours between 2000 and 2020. During the same period, demand for natural gas in vehicles will go from 46 to 150 million therms.

Figure 1.4: Historical and Projected On-Road Gasoline and Diesel Demand, 1980-2020

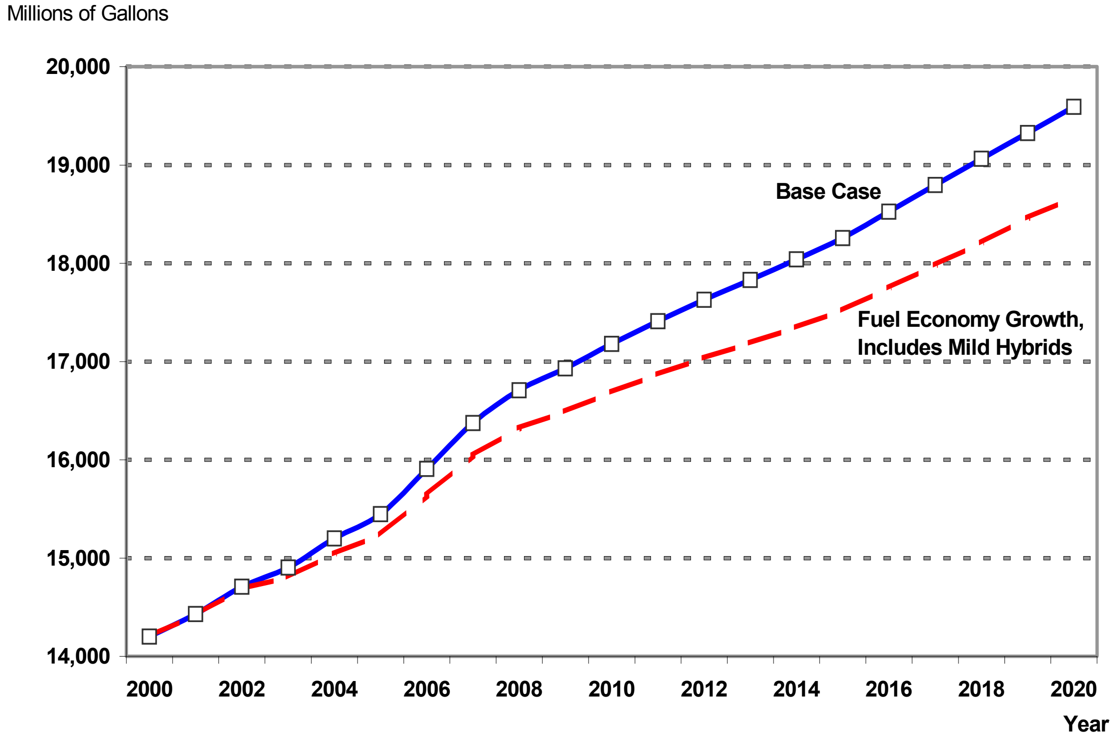


Alternative Forecast

The Energy Commission also examined the effects of a more optimistic fuel economy scenario. In this scenario, the fuel economy of new conventional light-duty vehicles grows slightly for all vehicle classes, assuming manufacturers adopt higher fuel economy, cost-effective technology while in-class weight growth trends continue with performance trends adjusted for weight growth. This assumption leads to average in-class growth for new vehicles of about 7 percent over the next 20 years. The underlying assumption behind this case is that lower average income growth (relative to the recent past) and an aging population will lead to new vehicle purchasers desiring some moderate gains in fuel economy. The scenario also assumes that 42-volt "mild" hybrids will achieve a significant level of sales penetration. The mild hybrids are projected to offer about a 10 percent fuel economy gain, with an incremental cost of $1000-$2000, over conventional gasoline vehicles. By 2010, 78 makes and models of mild hybrids are included, which translates to a penetration rate of around 16 percent each year between 2010 and 2020. The assumptions regarding full hybrids are the same as in the base forecast.

Figure 1.5 compares projected gasoline demand in this scenario with that projected in the base case. The results show that fuel economy growth in this alternative forecast would reduce gasoline demand by about 500 million gallons in 2010 and by slightly over 900 million gallons by 2020.

Figure 1.5: Projected On-Road Gasoline Demand, Base Case and Alternative Case, 2000-2020



End Notes

[1] The US Environmental Protection Agency's CAFE standard is an example of such policies.

[2] Note that fuel cost per mile is equal to the price per unit of fuel divided by fuel efficiency (miles traveled per unit of fuel).

[3] *State Energy Data Report 1999,* Energy Information Administration, U.S. Department of Energy, Washington, D.C., May 2001.

[4] Based upon data from the Energy Information Administration, U.S. Department of Energy, *Fuel Oil and Kerosene Sales 1998*, Tables 23 and 24, Washington, D.C., August 1999.

[5] *The UCLA Anderson Forecast for the Nation and California*, University of California, Los Angeles, September 1999, B-3 to B-6.

[6] *Light-Duty Automotive Technology and Fuel Economy Trends, 1975 Through 2001*, U.S. Environmental Protection Agency, September 2001.

[7] The Energy Commission's CALCARS vehicle choice model assumes buyers for a given class will choose a conventional, mild, or full hybrid vehicle, when available, based on vehicle attributes including vehicle price, fuel economy, range, performance and number of make/models. In the case of full hybrid vehicles, price was reduced for each type by the same percentage until the AT-PZEV requirements were met.

[8] Gasoline in the future will likely include about 6 percent ethanol by volume to meet the federal oxygenate requirement for gasoline in certain parts of the state. As oxygenates will be required for about 80 percent of the gasoline by 2003, it will probably be more practical for refiners to produce only gasoline with oxygenates.

[9] The year 2010 was chosen as the final year of increase since that is when the baby boomers begin to reach retirement age. Some evidence suggests that drivers 65 and over are less likely to choose an SUV for their next vehicle than those in their forties and fifties (from staff analysis of the *1995 National Personal Transportation Survey*, sponsored by the U.S. Department of Transportation).

[10] Some of the major factors driving the increase in SUV penetration over the last few years (changes in taste, safety concerns, status, etc.) could not be incorporated in the CALCARS model used to forecast LDV demand and usage. Therefore, an exogenous "trend" variable was introduced to increase SUV penetration rates in the forecast.